ROCHESTER

Minnesota

Building Safety Department

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2009 Mechanical & Energy Code – Ventilation, Makeup and Combustion Air Calculations - Instructions and Example

These instructions and blank submittal forms are available at the Building Safety website and at the Building Safety office. The completed form must be submitted at the time of application of a mechanical permit for new construction. Additional forms may be downloaded and printed at: http://www.rochestermn.gov/departments/bldgsafety

Site address				**Date**	
Contractor		**Completed By**			

Section A

Ventilation Quantity (Determine quantity by using Table N1104.2 or Equation 11-1)			
Square feet (Conditioned area including Basement – finished or unfinished)	3000	Total required ventilation	120
Number of bedrooms	3	Continuous ventilation	60

Directions - Determine the total and continuous ventilation rate by either using Table N1104.2 or equation 11-1. Insert the square footage, total required ventilation and continuous ventilation in the Mechanical Submittal form. The table and equation are below.

Table N1104.2

Total and Continuous Ventilation Rates (in cfm)

	Number of Bedrooms					
	1	2	3	4	5	6
Conditioned space (in sq. ft.)	Total/ continuous	Total/ continuous	Total/ continuous	Total/ continuous	Total/ continuous	Total/ continuous
1000-1500	60/40	75/40	90/45	105/53	120/60	135/68
1501-2000	70/40	85/43	100/50	115/58	130/65	145/73
2001-2500	80/40	95/48	110/55	125/63	140/70	155/78
2501-3000	90/45	105/53	120/60	135/68	150/75	165/83
3001-3500	100/50	115/58	130/65	145/73	160/80	175/88
3501-4000	110/55	125/63	140/70	155/78	170/85	185/93
4001-4500	120/60	135/68	150/75	165/83	180/90	195/98
4501-5000	130/65	145/73	160/80	175/88	190/95	205/103
5001-5500	140/70	155/78	170/85	185/93	200/100	215/108
5501-6000	150/75	165/;83	180/90	195/98	210/105	225/113

Equation 11-1

(0.02 x square feet of conditioned space) + [15 x (number of bedrooms + 1)] = Total ventilation rate (cfm)

Example: (0.02 x 3000) +[15 x (3 + 1)] = Total ventilation rate = 120 cfm

Total ventilation – The mechanical ventilation system shall provide sufficient outdoor air to equal the total ventilation rate average, for each one-hour period according to the above table or equation. For heat recovery ventilators (HRV) and energy recovery ventilators (ERV) the average hourly ventilation capacity must be determined in consideration of any reduction of exhaust or out outdoor air intake, or both, for defrost or other equipment cycling.

Continuous ventilation - A minimum of 50 percent of the total ventilation rate, but not less than 40 cfm, shall be provided, on a continuous rate average for each one-hour period. The portion of the mechanical ventilation system intended to be continuous may have automatic cycling controls providing the average flow rate for each hour is met.

Section B

Ventilation Method (Choose either balanced or exhaust only)					
☐ Balanced, HRV (Heat Recovery Ventilator) or ERV (Energy Recovery Ventilator) – cfm of unit in low must not exceed continuous ventilation rating by more than 100%.				☒ Exhaust only Continuous fan rating in cfm	
Low cfm:		High cfm:		Continuous fan rating in cfm (capacity must not exceed continuous ventilation rating by more than 100%)	80

Directions - Choose the method of ventilation, balanced or exhaust only. Balanced ventilation systems are typically HRV or ERV's. Enter the low and high cfm amounts. Low cfm air flow must be equal to or greater than the required continuous ventilation rate and less than 100% greater than the continuous rate. (For instance, if the low cfm is 40 cfm, the ventilation fan must not exceed 80 cfm.) Automatic controls may allow the use of a larger fan that is operated a percentage of each hour.

Section C

Ventilation Fan Schedule			
Description	Location	Continuous	Total Ventilation
Exhaust fan	Main bathroom	80	
Exhaust fan	Master bathroom		80
Hood	Kitchen		150

Directions - The ventilation fan schedule should describe what the fan is for, the location, cfm, and whether it is used for continuous or total ventilation. The fan that is chose for continuous ventilation must be equal to or greater than the low cfm air rating and less than 100% greater than the continuous rate. (For instance, if the low cfm is 40 cfm, the continuous ventilation fan must not exceed 80 cfm.) Automatic controls may allow the use of a larger fan that is operated a percentage of each hour.

Section D

Ventilation Controls (Describe operation and control of the continuous ventilation)
For this specific example, the main bathroom is the fan for continuous ventilation. Locate the switch in close proximity to the main bathroom. This switch must be labeled. An indicator light may be grouped with the switch if it is centrally located or remotely located in a central location. When a switch is utilized the indicator light must be on when the required continuous ventilation fan is operational.

Directions - Describe the operation of the ventilation system. There should be adequate detail for plan reviewers and inspectors to verify design and installation compliance. Related trades also need adequate detail for placement of controls and proper operation of the building ventilation. If exhaust fans are used for building ventilation, describe the operation and location of any controls, indicators and legends. If an ERV or HRV is to be installed, describe how it will be installed. If it will be connected and interfaced with the air handling equipment, please describe such connections as detailed in the manufactures' installation instructions. If the installation instructions require or recommend the equipment to be interlocked with the air handling equipment for proper operation, such interconnection shall be made and described.

Section E

Make-up air for ventilation			
	Passive (determined from calculations from Table 501.4.1)		
	Powered (determined from calculations from Table 501.4.1)		
	Interlocked with exhaust device (determined from calculation from Table 501.4.1)		
	Other, describe:		
Location of duct or system ventilation make-up air: Determined from make-up air opening table			
NR	Cfm		Size and type (round, rectangular, flex or rigid)

(NR means not required)

Directions - In order to determine the makeup air for ventilation, Table 501.4.1 must be filled out (see below). For most new installations, column A will be appropriate, however, if kitchen hoods exceed 300 cfm, atmospherically vented appliances or solid fuel appliances are installed, use the appropriate column. Please note, if the makeup air quantity is negative, no additional makeup air will be required for ventilation, if the value is positive refer to Table 501.4.2 and size the opening. Transfer the cfm, size of opening and type (round, rectangular, flex or rigid) to the last line of section D. The ventilation make-up air supply must communicate with the exhaust appliances.

Table 501.4.1
PROCEDURE TO DETERMINE MAKEUP AIR QUANITY FOR EXHAUST EQUIPMENT IN DWELLINGS
(Additional makeup air will be required for combustion appliances, see KAIR method for calculations)

	One or multiple power vent or direct vent appliances or no combustion appliances Column A	One or multiple fan-assisted appliances and power vent or direct vent appliances Column B	One atmospherically vent gas or oil appliance or one solid fuel appliance Column C	Multiple atmospherically vented gas or oil appliances or solid fuel appliances Column D
1. a) pressure factor (cfm/sf)	0.15	0.09	0.06	0.03
b) conditioned floor area (sf) (including unfinished basements)	3000			
Estimated House Infiltration (cfm): [1a x 1b]	450			
2. Exhaust Capacity a) continuous exhaust-only ventilation system (cfm); (not applicable to balanced ventilation systems such as HRV)	80			
b) clothes dryer (cfm)	135	135	135	135
c) 80% of largest exhaust rating (cfm); (not applicable if recirculating system or if powered makeup air is electrically interlocked and match to exhaust)	150 x .8 = 120			
d) 80% of next largest exhaust rating (cfm); (not applicable if recirculating system or if powered makeup air is electrically interlocked and matched to exhaust)	NA			
Total Exhaust Capacity (cfm); [2a + 2b +2c + 2d]	335			
3. Makeup Air Quantity (cfm) a) total exhaust capacity (from above)	335			
b) estimated house infiltration (from above)	450			
Makeup Air Quantity (cfm); [3a – 3b] (if value is negative, no makeup air is needed)	-115			
4. For makeup Air Opening Sizing, refer to Table 501.4.2	Not required, negative number			

A. Use this column if there are other than fan-assisted or atmospherically vented gas or oil appliance or if there are no combustion appliances. (Power vent and direct vent appliances may be used.)
B. Use this column if there is one fan-assisted appliance per venting system. (Appliances other than atmospherically vented appliances may also be included.)
C. Use this column if there is one atmospherically vented (other than fan-assisted) gas or oil appliance per venting system or one solid fuel appliance.
D. Use this column if there are multiple atmospherically vented gas or oil appliances using a common vent or if there are atmospherically vented gas or oil appliances and solid fuel appliances.

Makeup Air Opening Table for New and Existing Dwelling
Table 501.4.2

	One or multiple power vent, direct vent appliances, or no combustion appliances Column A	One or multiple fan-assisted appliances and power vent or direct vent appliances Column B	One atmospherically vented gas or oil appliance or one solid fuel appliance Column C	Multiple atmospherically vented gas or oil appliances or solid fuel appliances Column D	Duct diameter
Passive opening	1 – 36	1 – 22	1 – 15	1 – 9	3
Passive opening	37 – 66	23 – 41	16 – 28	10 – 17	4
Passive opening	67 – 109	42 – 66	29 – 46	18 – 28	5
Passive opening	110 - 163	67 – 100	47 – 69	29 – 42	6
Passive opening	164 – 232	101 – 143	70 – 99	43 – 61	7
Passive opening	233 – 317	144 – 195	100 – 135	62 – 83	8
Passive opening w/motorized damper	318 – 419	196 – 258	136 – 179	84 – 110	9
Passive opening w/motorized damper	420 – 539	259 – 332	180 – 230	111 – 142	10
Passive opening w/motorized damper	540 – 679	333 – 419	231 – 290	143 – 179	11
Powered makeup air	>679	>419	>290	>179	NA

Notes:

A. An equivalent length of 100 feet of round smooth metal duct is assumed. Subtract 40 feet for the exterior hood and ten feet for each 90- degree elbow to determine the remaining length of straight duct allowable.

B. If flexible duct is used, increase the duct diameter by one inch. Flexible duct shall be stretched with minimal sags. Compressed duct shall not be accepted.

C. Barometric dampers are prohibited in passive makeup air openings when any atmospherically vented appliance is installed.

D. Powered makeup air shall be electrically interlocked with the largest exhaust system.

Sections F

Make-up air for combustion			
	Not required per mechanical code (No atmospheric or power vented appliances)		
X	Passive (see IFGC Appendix E, Worksheet E-1)	Size and type	4” Rigid duct or 5” Flex
	Other, describe:		

Explanation - If no atmospheric or power vented appliances are installed, check the appropriate box, not required. If a power vented or atmospherically vented appliance installed, use IFGC Appendix E, Worksheet E-1 (see below). Please enter size and type. Combustion air vent supplies must communicate with the appliance or appliances that require the combustion air.

Section F calculations follow on the next 2 pages.

Directions - The Minnesota Fuel Gas Code method to calculate to size of a required combustion air opening, is called the Known Air Infiltration Rate Method. For new construction, 4b of step 4 is required to be filled out. The example assumes a typical 3,000 square foot home with a finished basement that has a mechanical room that is 10 feet wide by 12 feet long with an 8 foot ceiling. It also assumes installation of a 70,000 btu, 2 pipe condensing furnace; and a 40,000 Btu, power vented water heater.

IFGC Appendix E, Worksheet E-1
Residential Combustion Air Calculation Method
(for Furnace, Boiler, and/or Water Heater in the Same Space)

Step 1: Complete vented combustion appliance information.

Furnace/Boiler:

__ Draft Hood (not fan-assisted) __ Fan Assisted & Power Vent X_ Direct Vent Input: _70,000_____ Btu/hr

Water Heater:

__ Draft Hood (not fan-assisted) X_ Fan Assisted & Power Vent __ Direct Vent Input: _40,000_____ Btu/hr

Step 2: Calculate the volume of the Combustion Appliance Space (CAS) containing combustion appliances.
The CAS includes all spaces connected to one another by code compliant openings. CAS volume: _960_ ft^3
L x H X W = 8 x 10 x 12 = 960 cubic feet

Step 3: Determine Air Changes per Hour (ACH)1
Default ACH values have been incorporated into Table E-1 for use with Method 4b (KAIR Method). If the year of construction or ACH is not known, use method 4a (Standard Method).

Step 4: Determine Required Volume for Combustion Air.

4a. Standard Method

Total Btu/hr input of all combustion appliances (DO NOT COUNT DIRECT VENT APPLIANCES) Input: _____ Btu/hr

Use Standard Method column in Table E-1 to find Total Required Volume (TRV) TRV: _____ ft^3

If CAS Volume (from Step 2) ***is greater than*** TRV then no outdoor openings are needed.
If CAS Volume (from Step 2) ***is less than*** TRV then go to **STEP 5.**

4b. Known Air Infiltration Rate (KAIR) Method

Total Btu/hr input of all fan-assisted and power vent appliances (DO NOT COUNT DIRECT VENT APPLIANCES) Input: _40,000_____ Btu/hr

Use Fan-Assisted Appliances column in Table E-1 to find Required Volume Fan Assisted (RVFA) RVFA: _3,000_____ ft^3

Total Btu/hr input of all non-fan-assisted appliances Input: ____0_____ Btu/hr

Use Non-Fan-Assisted Appliances column in Table E-1 to find Required Volume Non-Fan-Assisted (RVNFA) RVNFA: ___none_____ ft^3

Total Required Volume (TRV) = RVFA + RVNFA TRV = _3,000___ + _none___ = _3,000__ ft^3

If CAS Volume (from Step 2) ***is greater than*** TRV then no outdoor openings are needed.
If CAS Volume (from Step 2) ***is less than*** TRV then go to **STEP 5.**

Step 5: Calculate the ratio of available interior volume to the total required volume. Ratio = CAS Volume (from Step 2) ***divided by*** TRV (from Step 4a or Step 4b)
Ratio = __960____ / _3,000__ = __.32_____

Step 6: Calculate Reduction Factor (RF).

RF = 1 ***minus*** **Ratio** Ratio RF = 1 - _____.32_____ = _____.68_____

Step 7: Calculate single outdoor opening as if all combustion air is from outside.
Total Btu/hr input of all Combustion Appliances in the same CAS (EXCEPT DIRECT VENT) Input: _40,000_____ Btu/hr

Combustion Air Opening Area (CAOA): Total Btu/hr ***divided by*** 3000 Btu/hr per in^2 CAOA = __40,000____ / 3000 Btu/hr per in^2 = ___13.3_ in^2

Step 8: Calculate Minimum CAOA.

Minimum CAOA = CAOA ***multiplied by*** RF Minimum CAOA = ___13.3____ x ____.68____ = ___9.07____ in^2

Step 9: Calculate Combustion Air Opening Diameter (CAOD)

CAOD = 1.13 ***multiplied by the square root of*** Minimum CAOA CAOD = 1.13 √ Minimum CAOA = _3.4___ in
CAOD = 1.13 x square root of 9.07 = 3.4 go to next size 4 inch rigid or 5 inch flex duct

1 If desired, ACH can be determined using ASHRAE calculation or blower door test. Follow procedures in Section G304.

IFGC Appendix E, Table E-1 Residential Combustion air (Required Interior Volume Based on Input Rating of Appliance)					
Input Rating (Btu/hr)	Standard Method	Known Air Infiltration Rate (KAIR) Method (cu ft)			
		Fan Assisted		Non-Fan Assisted	
		1994 to present	Pre-1994	1994 to present	Pre-1994
5,000	250	375	188	525	263
10,000	500	750	375	1,050	525
15,000	750	1,125	563	1,575	788
20,000	1,000	1,500	750	2,100	1,050
25,000	1,250	1,875	938	2,625	1,313
30,000	1,500	2,250	1,125	3,150	1,575
35,000	1,750	2,625	1,313	3,675	1,838
40,000	2,000	3,000	1,500	4,200	2,100
45,000	2,250	3,375	1,688	4,725	2,363
50,000	2,500	3,750	1,675	5,250	2,625
55,000	2,750	4,125	2,063	5,775	2,888
60,000	3,000	4,500	2,250	6,300	3,150
65,000	3,250	4,875	2,438	6,825	3,413
70,000	3,500	5,250	2,625	7,350	3,675
75,000	3,750	5,625	2,813	7,875	3,938
80,000	4,000	6,000	3,000	8,400	4,200
85,000	4,250	6,375	3,188	8,925	4,463
90,000	4,500	6,750	3,375	9,450	4,725
95,000	4,750	7,125	3,563	9,975	4,988
100,000	5,000	7,500	3,750	10,500	5,250
105,000	5,250	7,875	3,938	11,025	5,513
110,000	5,500	8,250	4,125	11,550	5,775
115,000	5,750	8.625	4,313	12,075	6,038
120,000	6,000	9,000	4,500	12,600	6,300
125,000	6,250	9,375	4,688	13,125	6,563
130,000	6,500	9,750	4,875	13,650	6,825
135,000	6,750	10,125	5,063	14,175	7,088
140,000	7,000	10,500	5,250	14,700	7,350
145,000	7,250	10,875	5,438	15,225	7,613
150,000	7,500	11,250	5,625	15,750	7,875
155,000	7,750	11,625	5,813	16,275	8,138
160,000	8,000	12,000	6,000	16,800	8,400
165,000	8,250	12,375	6,188	17,325	8,663
170,000	8,500	12,750	6,375	17,850	8,925
175,000	8,750	13,125	6,563	18,375	9,188
180,000	9,000	13,500	6,750	18,900	9,450
185,000	9,250	13,875	6,938	19,425	9,713
190,000	9,500	14,250	7,125	19,950	9,975
195,000	9,750	14,625	7,313	20,475	10,238
200,000	10,000	15,000	7,500	21,000	10,500
205,000	10,250	15,375	7,688	21,525	10,783
210,000	10,500	15,750	7,875	22,050	11,025
215,000	10,750	16,125	8,063	22,575	11,288
220,000	11,000	16,500	8,250	23,100	11,550
225,000	11,250	16,875	8,438	23,625	11,813
230,000	11,500	17,250	8,625	24,150	12,075

1 The 1994 date refers to dwellings constructed under the 1994 Minnesota Energy Code. The default KAIR used in this section of the table is 0.20 ACH.

2 This section of the table is to be used for dwellings constructed prior to 1994. The default KAIR used in this section of the table is 0.40 ACH.